GMI Aerosol Module Intercomparison II: 2-D Model Intercomparison of Modal and Sectional Aerosol Approaches

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Microphysical Modules:

AER: 40 bins, 0.39 nm - 3.2 μm, 2x volume

UMaer: 3 modes, 2 moments, fixed lognormal widths

Nucleation (Vehkamaeki et al., 2002): $\frac{dN}{dt}, \frac{dM}{dt}$

Coagulation: $\frac{dN}{dt} \sim r_{vol}$

Condensation/Evaporation: $\frac{dM}{dt} \sim r_{vol}$

Sedimentation: $\frac{dN}{dt} \sim r_{eff1}, \frac{dM}{dt} \sim r_{eff2}$

Summary of Box Model Intercomparison

360 cases: 850, 500, 200, 50 mb

January and July conditions, extrema in T, RH, SO_4

10 day integrations

Herzog et al. (2004) JGR 2003JD004405

2-modes, 4-modes, 40 bins vs 150 bins

4-mode version within factor of 1.2 of 150 bin model

2-D Intercomparison in AER Framework: Stratosphere and Troposphere

Pole to Pole, 0-60 km, 9.5° x 1.2 km

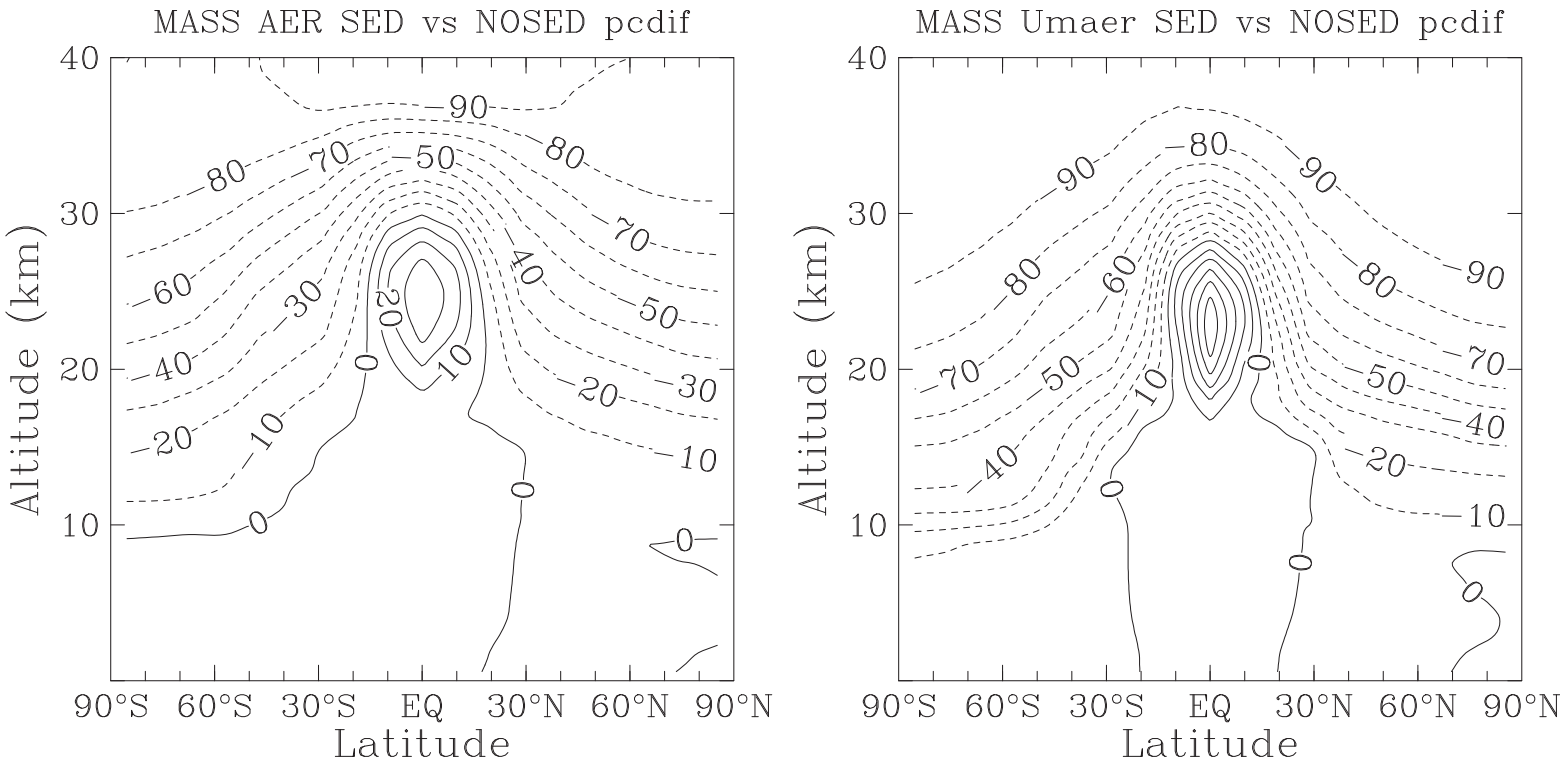
Transport: Advection, Eddy Diffusion,
Sedimentation (accumulation from above)

Multi-year integrations to steady-state

Timing: 3-modes runs 53 minutes/year
40 bins runs 104 minutes/year

*Calculations with and without sedimentation
- aerosol mass should be same for both models
- simpler interpretation - faults uncovered

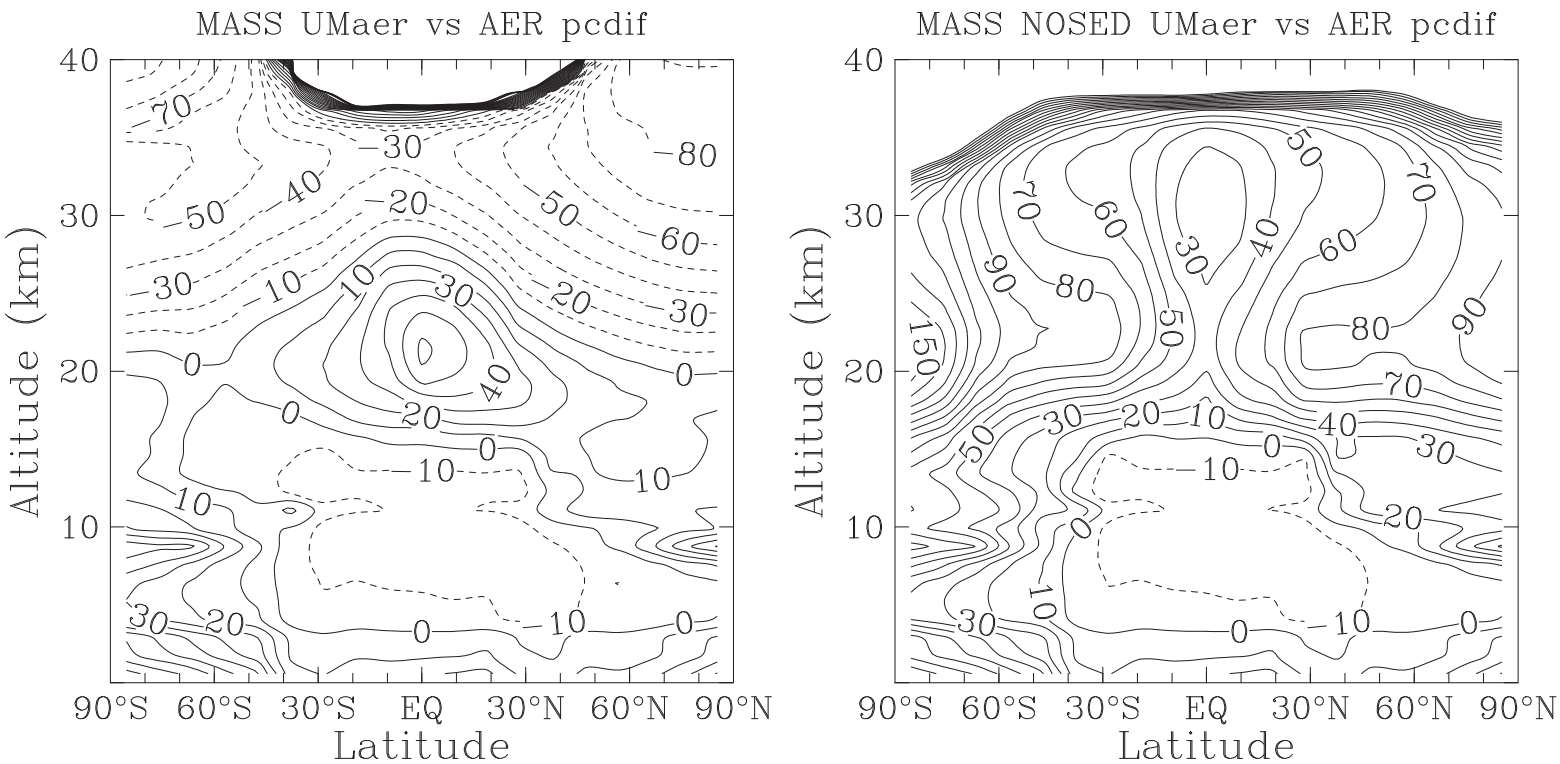
Sedimentation Effect on Mass Density, Annual Average



Sedimentation balances upwelling in tropics at 20-25 km

Sedimentation has bigger impact in UMaer (??)

Mass Density Comparison, Annual Average



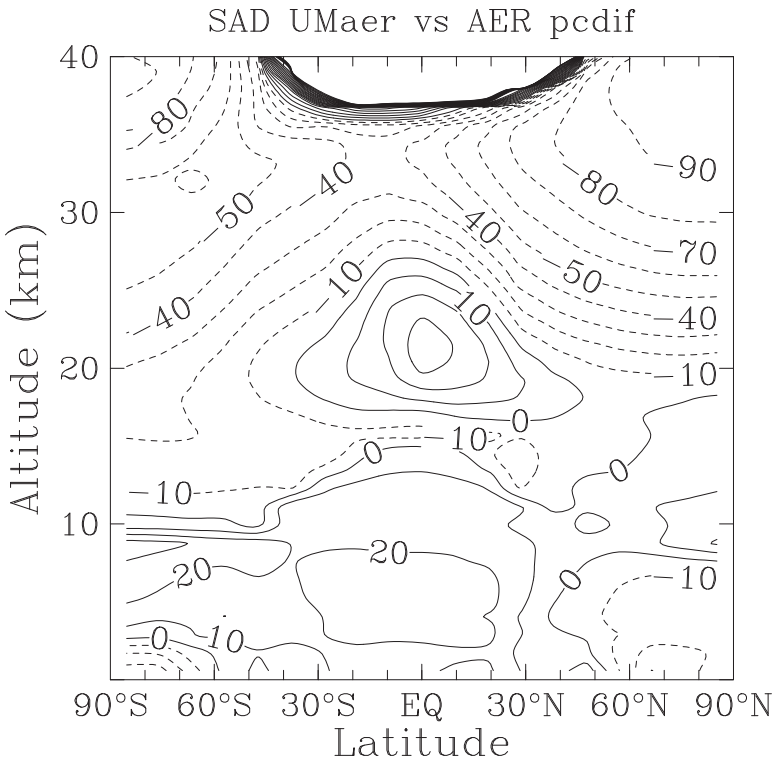
Nosed Problems: AER - 500 ppt total sulfur too small

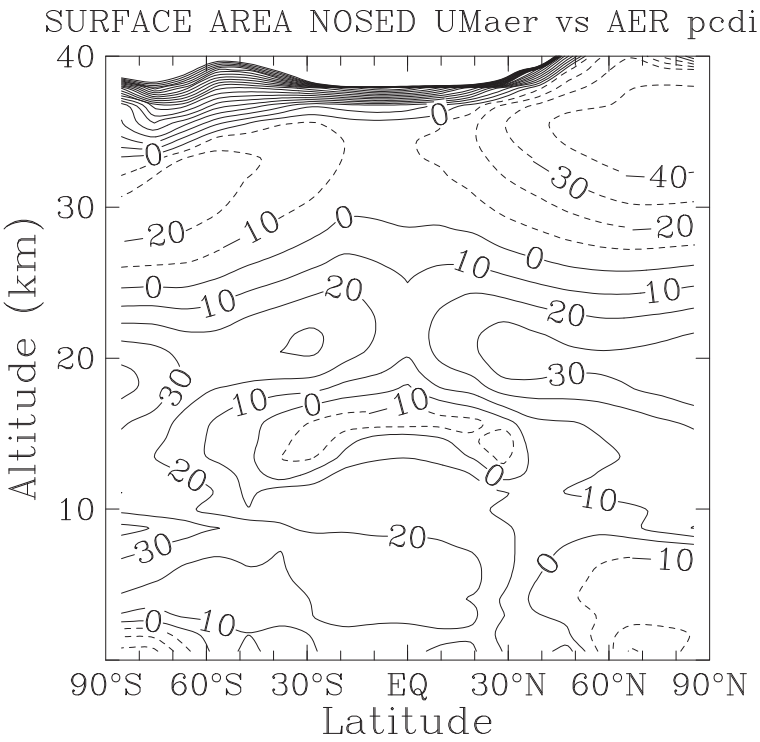
UMaer - particles evaporate much too slowly

– this probably causes excess sedimentation

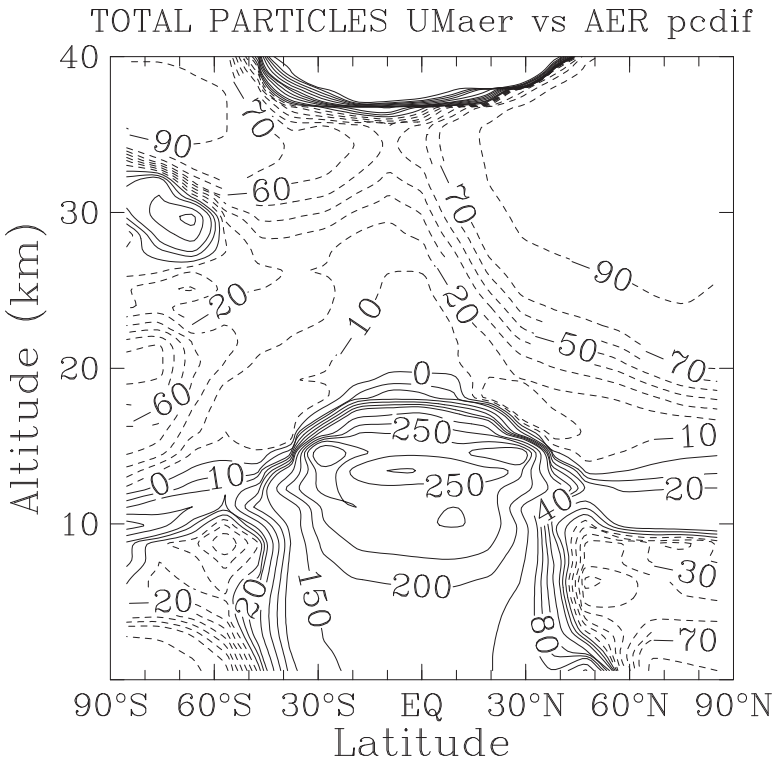
Strat burdens UMaer +15% with sed, UMaer +51% no sed

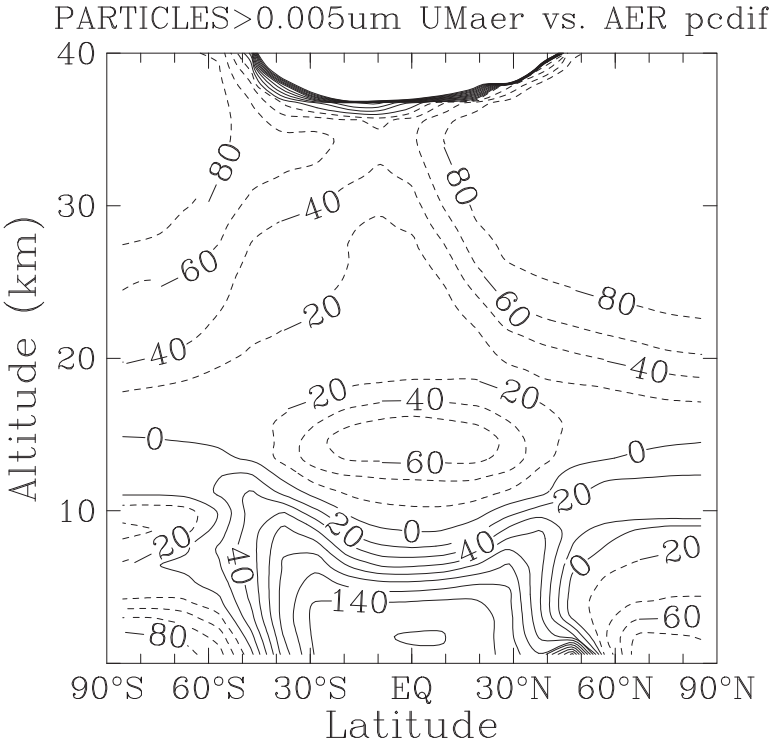
Surface Area Comparison, Annual Average



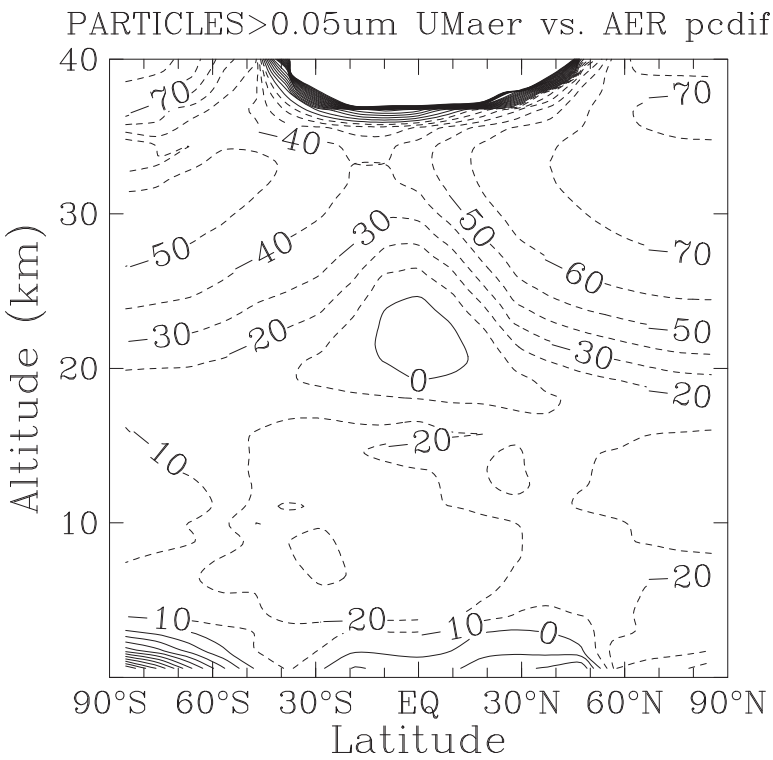


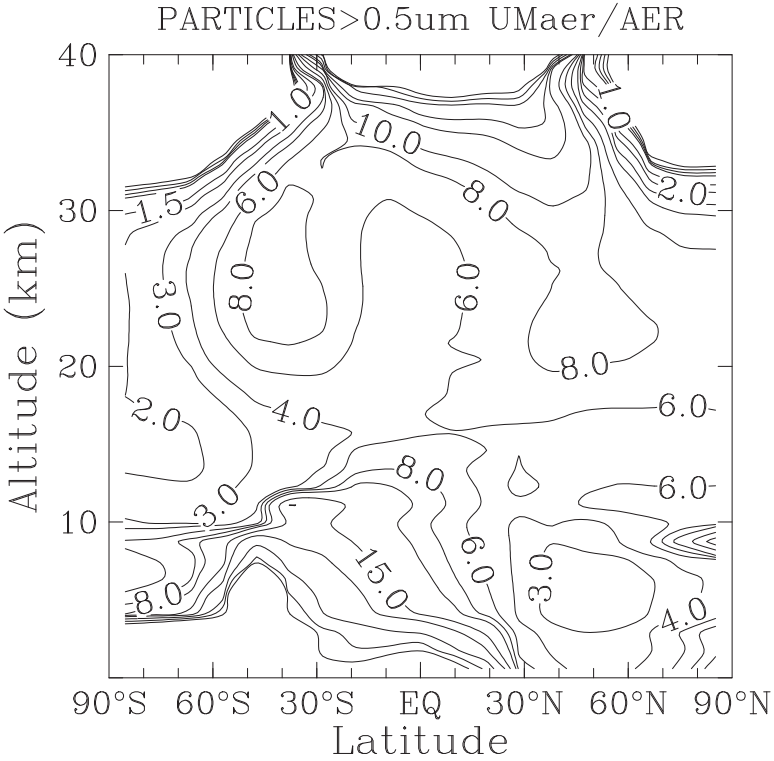
Particle Number Density Comparison, Annual Average



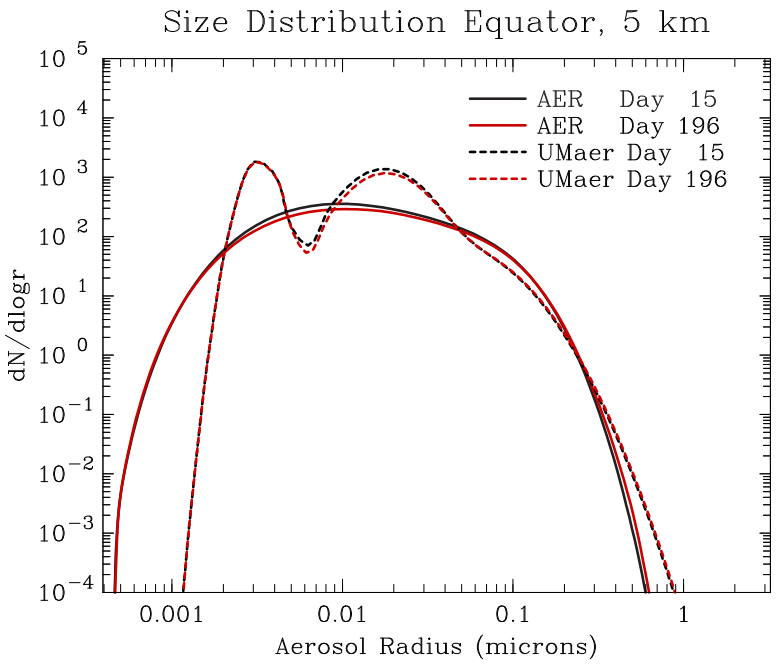


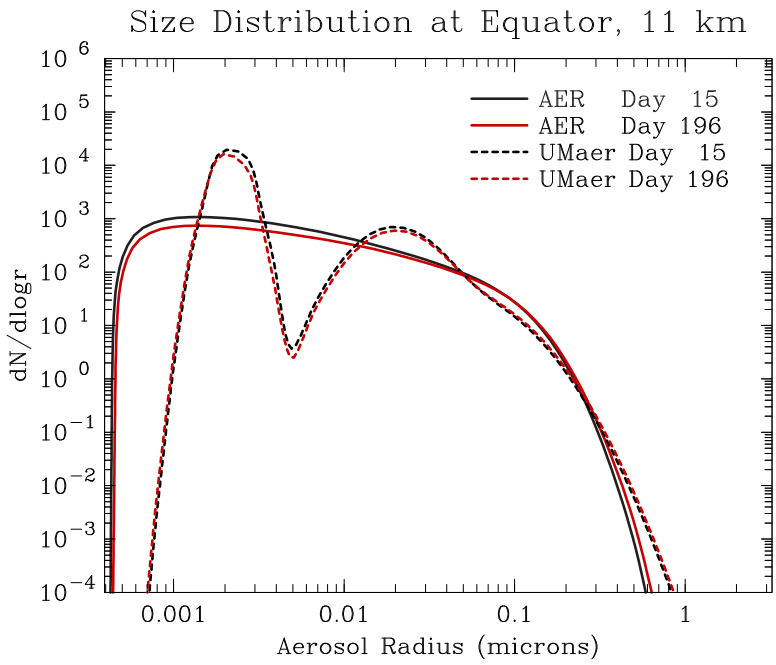
Particle Number Density Comparison, Annual Average





Size Distribution at Equator

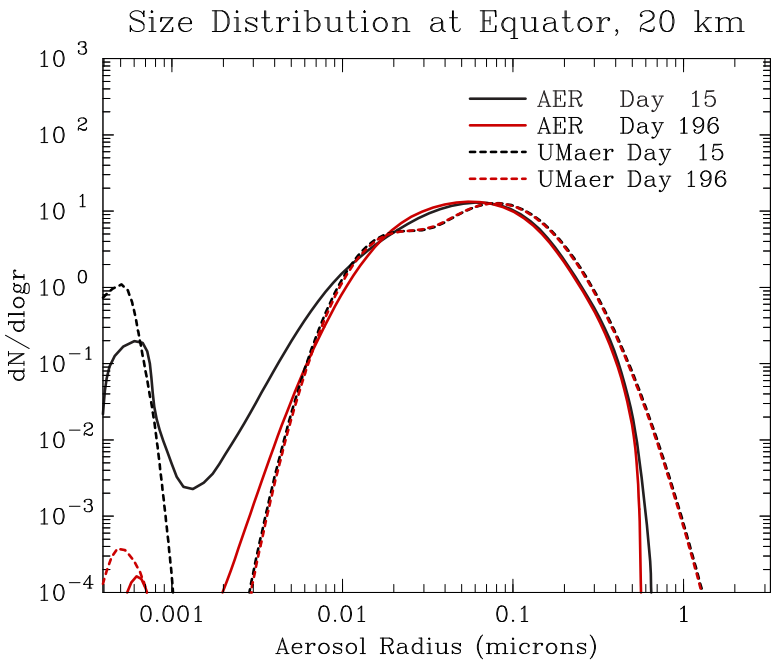


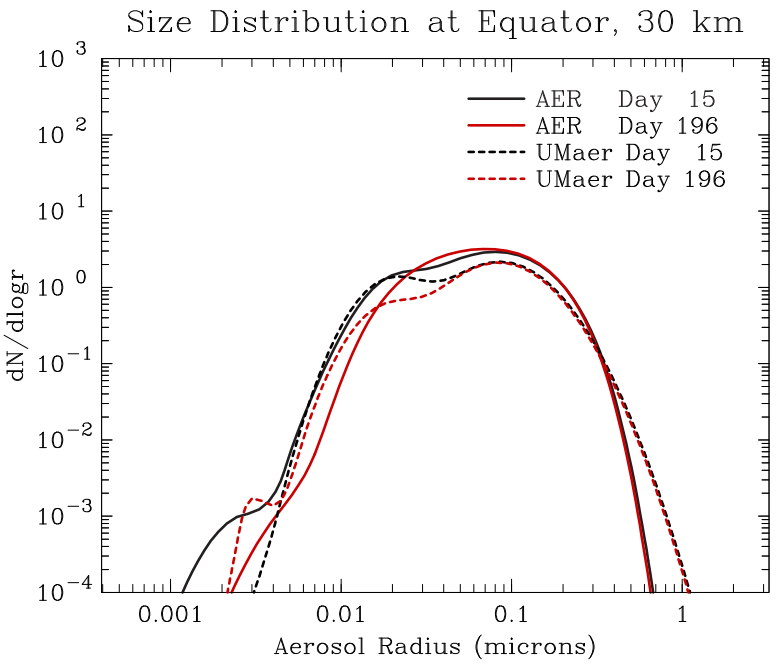


5 km: UMaer Mass -10%, SAD +20%, N +200%, N>0.005 +120%

11 km: UMaer Mass -10%, SAD +15%, N +25-%, N>0.005 same

Size Distribution at Equator

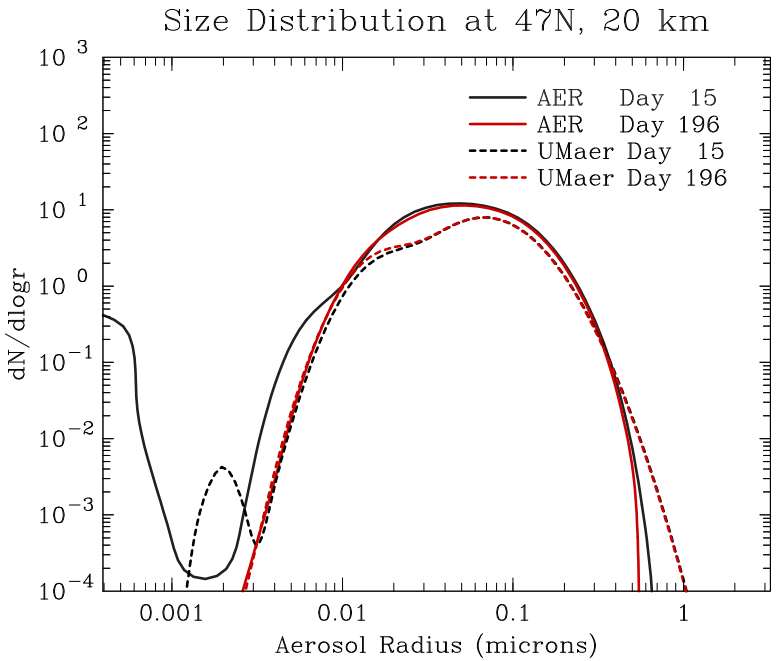


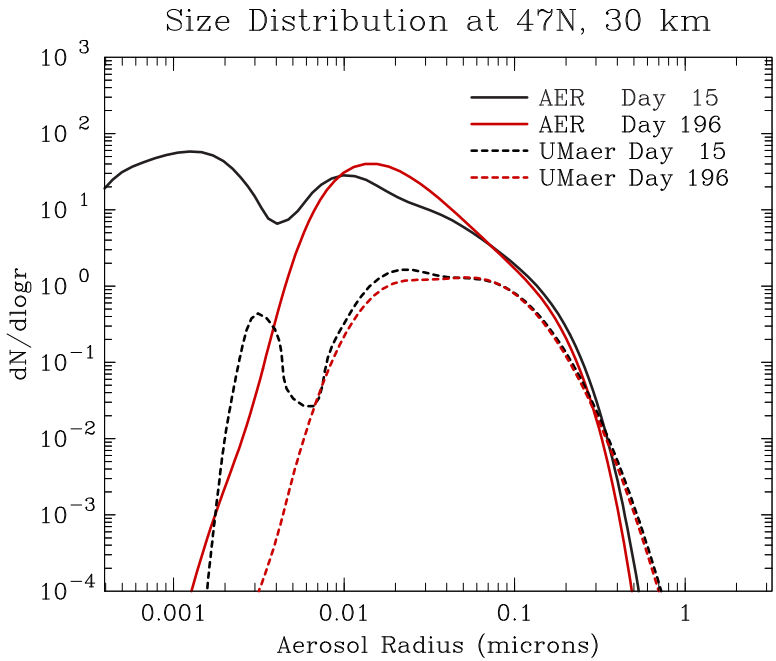


20 km: UMaer Mass +40%, SAD +30%, N same, N>0.005 -60%

30 km: UMaer Mass -20%, SAD -30%, N -30%, N>0.005 -40%

Size Distribution at 47°N





20 km: UMaer Mass +10%, SAD same, N -20%, N>0.005 -30%

30 km: UMaer Mass -50%, SAD -60%, N -90%, N>0.005 -80%